FISKERIDIREKTORATETS SKRIFTER
Serie Havundersøkelser
(Report on Norwegian Fishery and Marine Investigations)
Vol. XII. No. 7

Investigations on Eggs and Larvae of Commercial Fishes in Norwegian Coastal and Offshore Waters in 1957–58

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1960
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INTRODUCTION

This paper is based on a material of eggs and larvae of commercial fishes collected during cruises in Norwegian coastal and offshore waters during the spring and summer in 1951, 1957 and 1958. Details are given in Table 1. The author has had the leadership of all the cruises.

In addition to this material, fish eggs and larvae collected in vertical Nansen net hauls at the permanent oceanographical station at Skrova in Lofoten, and in horizontal and vertical hauls at st. M, (66° N, 02° E) during the same periods have also been used for the investigation.

All material has been preserved in 5—10% formalin.

During the working the fish eggs and larvae were investigated under a low-powered stereoscopic microscope (9—50x) and measured by means of a built-in micrometer. Larger fish fry were measured under a low-powered lens, and the lengths adjusted to the nearest millimetre.

Most of the sorting and measurements of fish eggs and larvae, and preparation of graphs and charts has been undertaken by Miss KARI NILSEN and Mrs. TORUNN LØTVEDT, and the author takes this opportunity to express his warmest thanks.

Kr. Fr. Wiborg.

INVESTIGATIONS ON EGGS OF COD AND HADDOCK

Earlier investigations (ALEJEV 1944, and others) have shown that the Barents Sea haddock mainly spawn in the bank and slope areas off northern Norway from Lofoten to Sørøy. Later investigations (WIBORG 1950—57) failed to reveal major concentrations of eggs and larvae in this area, although in some years (1948, 1954) the larvae were fairly abundant.

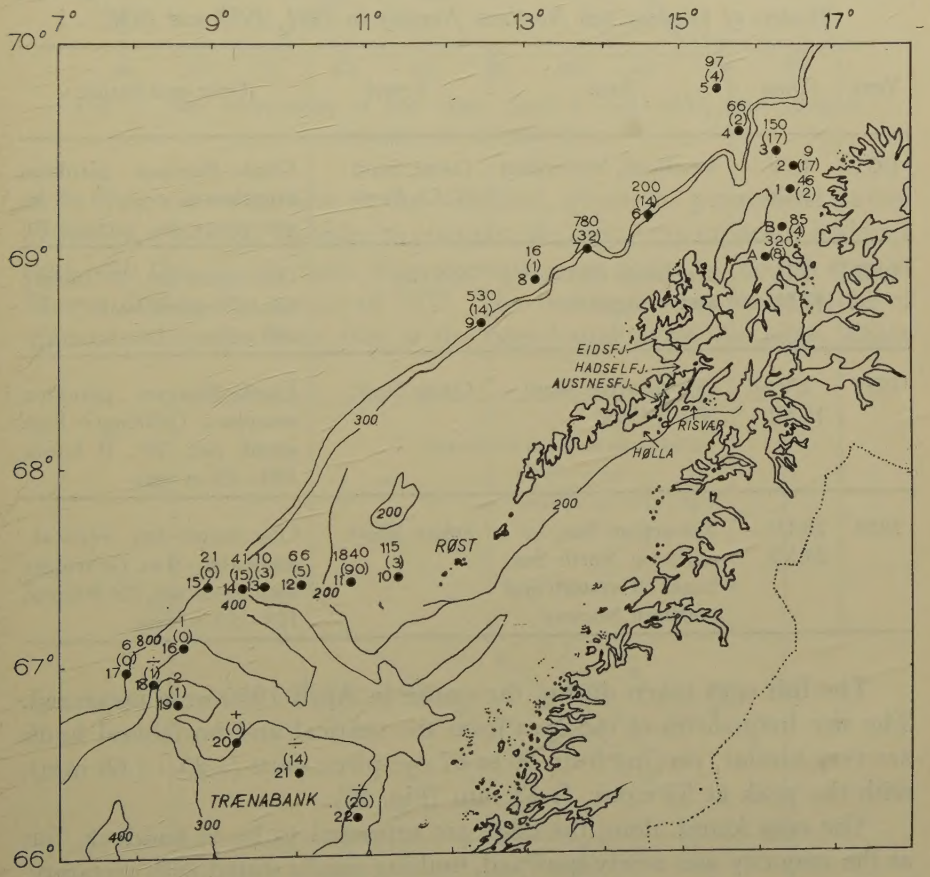

Fig. 1. Distribution of fish eggs, 1.—12. April 1957. Left, station number, above, number of eggs per 10 minutes surface hauls with the one metre net, in brackets, number of eggs in vertical hauls 100—0 m with the same net.

The cruise in April 1957 was specially planned to locate the centre of spawning of the haddock in the area mentioned. In 10 minutes horizontal hauls at the surface 60—800 fish eggs were taken along the edge, up to 1840 eggs on the Røst bank. (Fig. 1). Few eggs were taken in the vertical hauls, maximum 90 eggs per haul, but the horizontal distribution agreed very well with that indicated by the surface hauls.

At the early stages of development eggs of cod and haddock are very difficult to distinguish. They are of nearly the same size and appearance, especially in the preserved state, diameter 1.3—1.6 mm. The haddock eggs are assumed to be slightly larger, and this character has been used in an attempt to distinguish these eggs from those of the cod (SAVILLE 1956).

Table 1. *Cruises with Collection of Fish Eggs and Larvae in Coastal and Offshore Waters of Western and Northern Norway in 1951, 1957 and 1958*

Year	Date	Area	Vessel	Gear and hauls
1951	4.IV—11.IV	Vestfjord, Vesterålen	Oscar Sund G. O. Sars	Clarke-Bumpus plankton samplers in steps 75—5 m, one metre net, surface, 10′
1957	1.IV—12.IV	The banks off Lofoten and Vesterålen	Asterias	One metre net, 10′ surface hauls, vertical hauls 100—0 m
1957	2.V—12.VI	Coastal areas Møre—North Cape	Oscar Sund	Clarke-Bumpus plankton samplers. Gehringer high speed net, 20′, 8 knots, 100—25 m wire
1958	28.IV—24.VI	Norwegian Sea, northern North Sea, banks off western and northern Norway	Johan Hjort	One metre net, vertical hauls 100—0 m. Gehringer high speed net, 25′,8 knots, 125—25 m wire

The fish eggs taken during the cruise in April 1956 were measured. The size frequencies of the eggs from the vertical and horizontal hauls are very similar, varying from 50 to 67 eye-piece units (1.25—1.68 mm), with the peak at 57 e.p.u. (1.43 mm (Fig. 2)).

The eggs found along the edge are supposed to be of haddock, but as the majority was newly spawned, nothing can be stated with certainty. In the inner part of the Andfjord the eggs were a little smaller.

As is generally known, the Arcto-Norwegian stock of cod has part

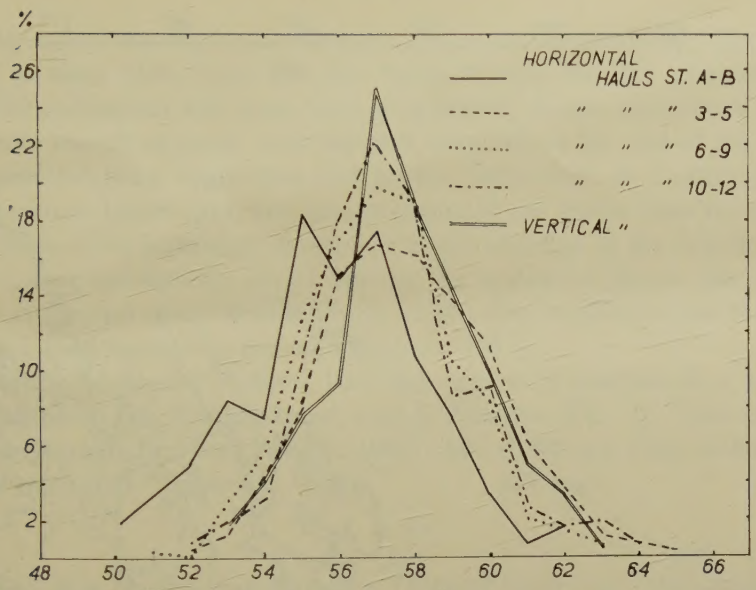

Fig. 2. Size frequencies of fish eggs, April 1.—12. 1957. One division corresponds to 0.025 mm.

of its main spawning area in the Vestfjord, where the permanent station at Skrova is located. In order to compare the size of the supposed haddock eggs with that of cod eggs, measurements were made of the fish eggs at Skrova during the spring of 1957. The cod eggs were found to be of approximately the same size as the eggs found along the edge. There

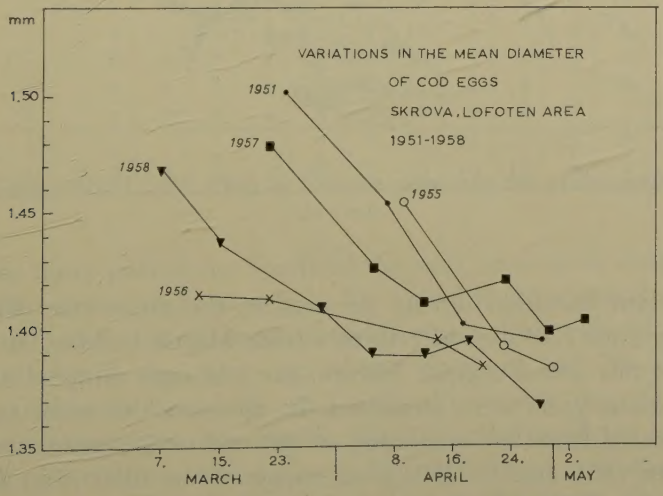

Fig. 3. Variations in the mean diameter of cod eggs at Skrova during the period March—May in various years.

Fig. 4. Stations, where fish eggs were sampled in April 1951. Further explanation in the text.

was a certain variation during the season, the mean size of the eggs decreasing from 1.48 mm to 1.40 mm from March to May. In order to find out if this was a regular feature, the cod eggs sampled at Skrova during various years were measured. In all years the mean size of the eggs decreased from the beginning to the end of the season, most pronounced in 1951 and 1957, less conspicuously in 1956 (Fig. 3).

It is generally known that the mean size of the eggs of a certain species of fish decreases during the spawning season. Heincke & Ehrenbaum

(1900) made thorough and extensive studies of this problem. They were able to show that there are two main reasons for this phenomenon. 1) The individual fish may have a spawning season sometimes lasting a whole month or more, and the eggs spawned at the end of the season are smaller than those spawned at the beginning. 2) Larger (older) fish produce larger eggs, and spawn earlier in the season than the smaller fish. Both these facts may be applied to the cod eggs in the Lofoten area. The larger cod usually arrive first in the spawning places, the smaller ones at the end of the season (Sund 1938). The individual cod may also have a long spawning period (Sorokin 1957).

At the beginning of April 1951 fish eggs were sampled at a number of stations in the Vestfjord and outside Lofoten (Fig. 4). This material has been treated earlier (Wiborg 1952). About 100 eggs from each station were measured (Table 2).

Table 2. *Size Frequencies of Fish Eggs Taken off Lofoten and Vesterålen 10.—12. April 1951 (Fig. 4). 1 e.p.u. = 0.025 mm.*

St.	*e.p.u.*															
	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66
76 ..		1		4	6	9	7	*10*	8	8	8	*20*	8	3	4	4
78 ..		4	4	13	13	*22*	14	11	9	8	1	1				
79 ..		1	6	11	14	13	*16*	14	10	5	2	3	1	3	1	
80 ..		3	7	11	*18*	15	14	12	9	6	3	1	1			
84 ..		1	6	6	10	17	21	*22*	8	4	3	1	1			
85 ..			4	11	*18*	14	14	8	14	4	7	6	1			
92 ..	1	2	8	8	19	*22*	13	14	6	9	—	1	2			
96 ..			1	5	5	14	16	*20*	17	8	9	3	2			
98 ..			2	1	2	4	3	8	9	8	3	*12*	7	2		
100 ..						2	3	6	13	22	24	22	6	2		
104 ..			2	3	5	7	*21*	17	18	10	11	5	1			

In the inner part of the Vestfjord the eggs were on an average a little larger than in the outer part (Fig. 5). This difference may be related to the size of the fish. On the banks outside Lofoten the eggs had the same size distribution as in the outer part of the Vestfjord (sts. 78—80, 84—85, 92, 104, Table 2), but along, and especially outside the edge, the eggs were averagely larger (sts. 76, 96, 98, 100 and Fig. 6), at st. 100 with the peak of the curve at 62 e.p.u. (1.55 mm). There is reason to believe that the larger eggs may be attributed to the haddock. The eggs were more abundant at st. 100 than along the edge.

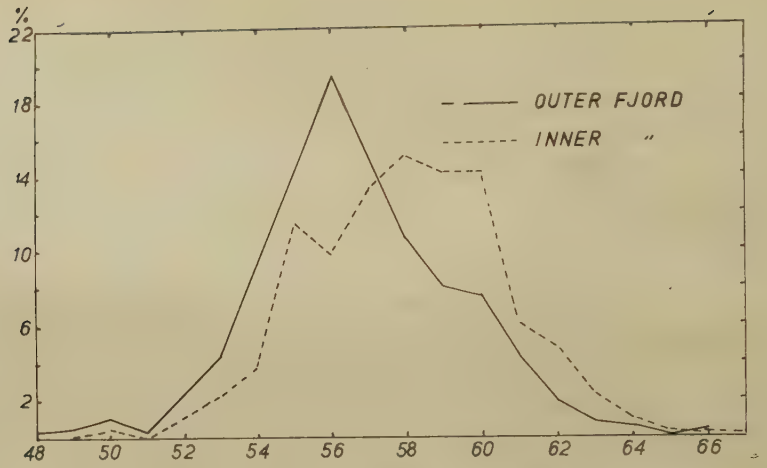

Fig. 5. Size frequencies of fish eggs in the Vestfjord, April 1951.

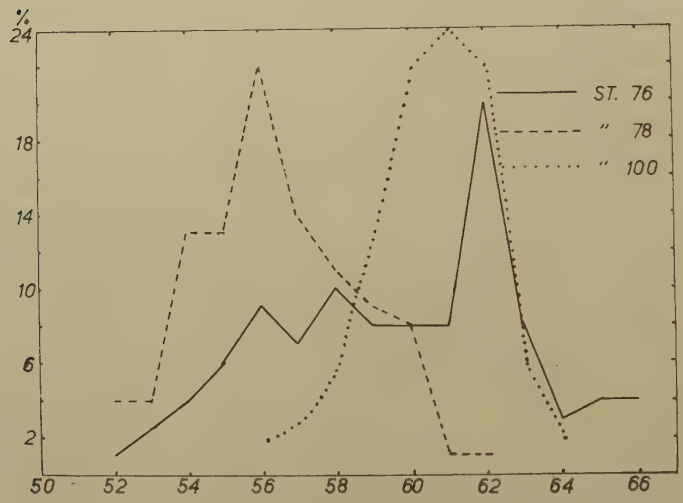

Fig. 6. Size frequencies of fish eggs from the banks outside Lofoten and Vesterålen, April 1951.

At st. "M" a number of fish eggs and a few haddock larvae were taken during the period April—June of the years 1954—56 and 1958. Eggs in later stages of development were determined as haddock eggs. Size measurements indicated that the eggs varied in size from 53 to 62 e.p.u. (1.30—1.55 mm), in 1955—56 with the maximum at 56—57 e.p.u., in 1954 at 60 e.p.u. Therefore, eggs of cod and haddock cannot always be separated merely according to the size frequencies.

OCCURRENCE AND DISTRIBUTION OF COD EGGS AND LARVAE IN 1957—58

Cod

At the beginning of May 1957 cod larvae were found in the inner Vestfjord in numbers of 40—60 per m^2 of sea surface, cod eggs, — 100—140 per m^2. At the beginning of June 25 cod larvae per m^2 were caught in sheltered fjords between Lofoten and Vesterålen. In other bank and fjord areas there were only 2—8 larvae per m^2.

At Skrova cod eggs and larvae were scarce throughout the whole spawning season. From the middle of March to the beginning of May the number of eggs varied between 15 and 87 per vertical haul. Single larvae were found from the end of April.

Investigations of cod eggs and larvae in earlier years (Wiborg 1958) seem to indicate that a relatively late hatching and few larvae at the beginning of May bear some relation to the appearance of a year class of fish of an average or above average size. If this will be the case for the 1957 year class of cod, cannot be stated until later, in 1960—62, when this year class will appear in the commercial fisheries in the Barents Sea.

In June 1957 the high speed net was used in order to catch larger fish fry. On the western side of the Lofoten Islands 1—8 cod fry were taken per haul, in the Vestfjord, 3—36 cod per haul, the majority on the Lofoten bank and in the innermost part of the fjord.

The average size of the fry decreased from the outer to the inner part of the fjord, indicating that the fry was drifting out of the fjord.

In the Austnesfjord, a small fjord near Skrova, a series of hauls was taken with varying wirelength, in order to investigate the occurrence of cod fry at different levels, as shown below.

Wire-length m.	Appr. depth	Number of cod fry
25	8	14
50	15	50
75	25	50
100	35	106
125	42	55

The majority of the cod fry was taken at a depth of appr. 35 m. The length frequencies are shown in Fig. 7.

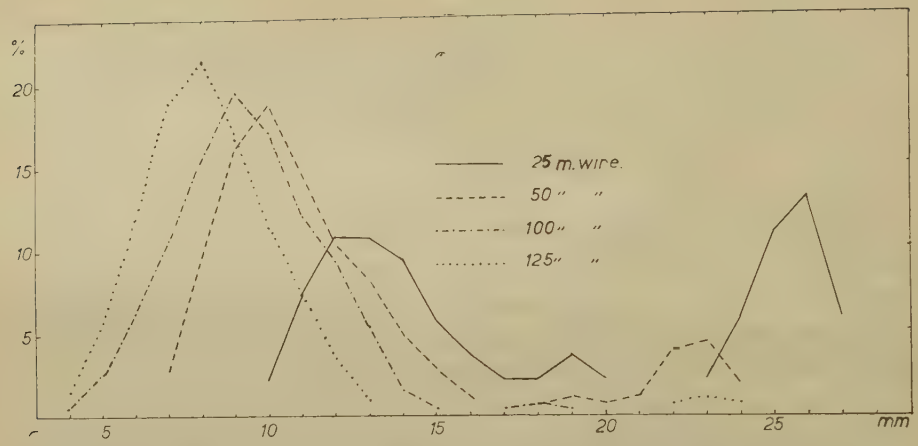

Fig. 7. Size frequencies of cod fry taken in a high speed net at different depths in the Austnesfjord, June 1957. Smoothed curves, $\left(\frac{a + 2b + c}{4}\right)$.

The average size of the fry evidently decreases with increasing depth. A greater pressure is possibly required during the development of the swim bladder. The hauls were taken in the middle of the day.

In 1958 eggs and larvae of cod were fairly abundant at the Skrova station (Fig. 8). In February few eggs were present, but in March the number increased to more than 1200 eggs per haul (3300 eggs per m^2), decreasing again during the following period to zero at the end of May. Cod larvae appeared at the beginning of April, with greatest abundance at the end of the month and in the middle of May. Later in the season the larvae probably avoided the Nansen net.

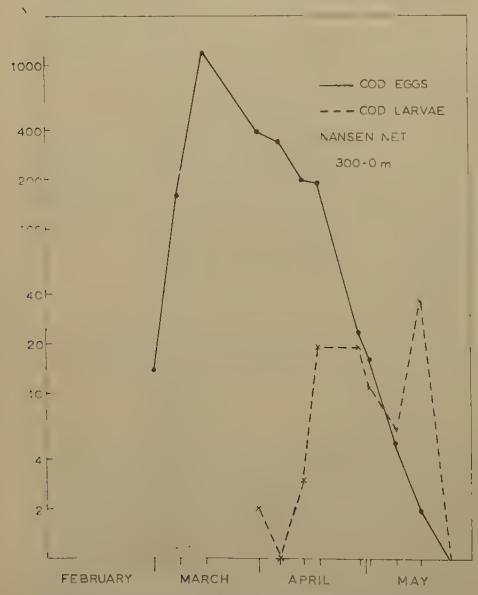

Fig. 8. Number of cod eggs and larvae in vertical Nansen net hauls at Skrova, February—May 1958.

At the end of May cod larvae were taken in vertical hauls with a one metre net off Lofoten and Vesterålen during the cruise of the "Johan Hjort" (see Wiborg 1960a), with a maximum of 27 individuals per haul, a few larvae also on the banks farther to the northeast (Fig 9). In the period 17.—24. June cod fry 10—30 mm in length were taken in the same area with the high speed net (Table 3).

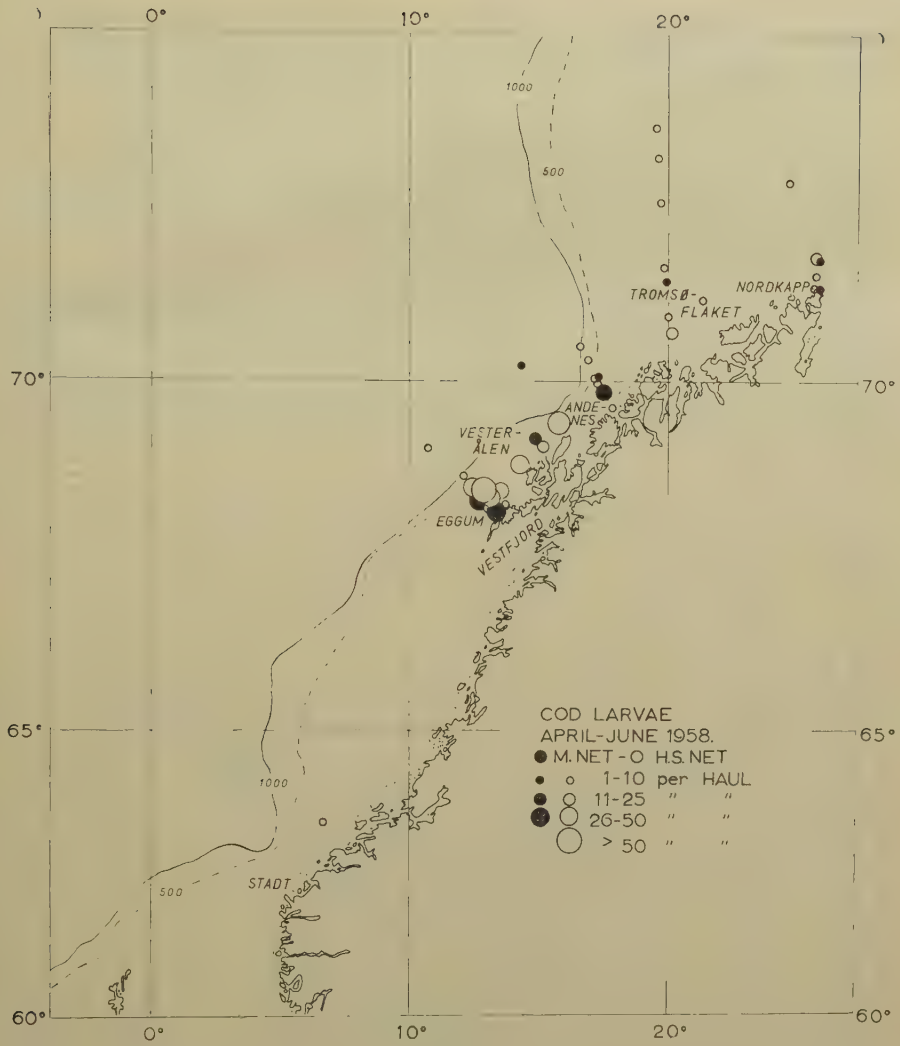

Fig. 9. Distribution of cod larvae in April—June 1958. Negative stations omitted.

Table 3. *Number and Length Distribution of Cod Fry Taken in a High Speed Net (125—25 m Wire, 25 Minutes, 8 Knots) 17.—24. June 1958 off Northwestern and Northern Norway.*

Area	No. per station	Length, mm						Mean length
		8— 12	13— 17	18— 22	23— 27	28— 32	33— 37	
Tromsøflaket—North Cape	18	—	11	17	8	—	—	19.8
Andenes—Eggum	55	2	25	53	24	6	1	20.4
Off Eggum	32	2	12	46	54	38	10	24.5

The mean length does not vary very much. The largest fry, caught off Eggum, measured averagely 24.5 mm.

Haddock

The occurrence of haddock eggs has in main been treated on pp. 7–12. In 1958 eggs and larvae of haddock were chiefly found in two areas (Fig. 10). At the end of April maximum 75 eggs and 11 larvae per vertical haul were taken on the Viking Bank, and east of Shetland. A few larvae and eggs also occurred on the Halten Bank and along the edge of the shelf. The other main area is situated off Vesterålen. Single larvae were taken in the open ocean far off shore. This agrees with the finding of haddock eggs in the same area in earlier years.

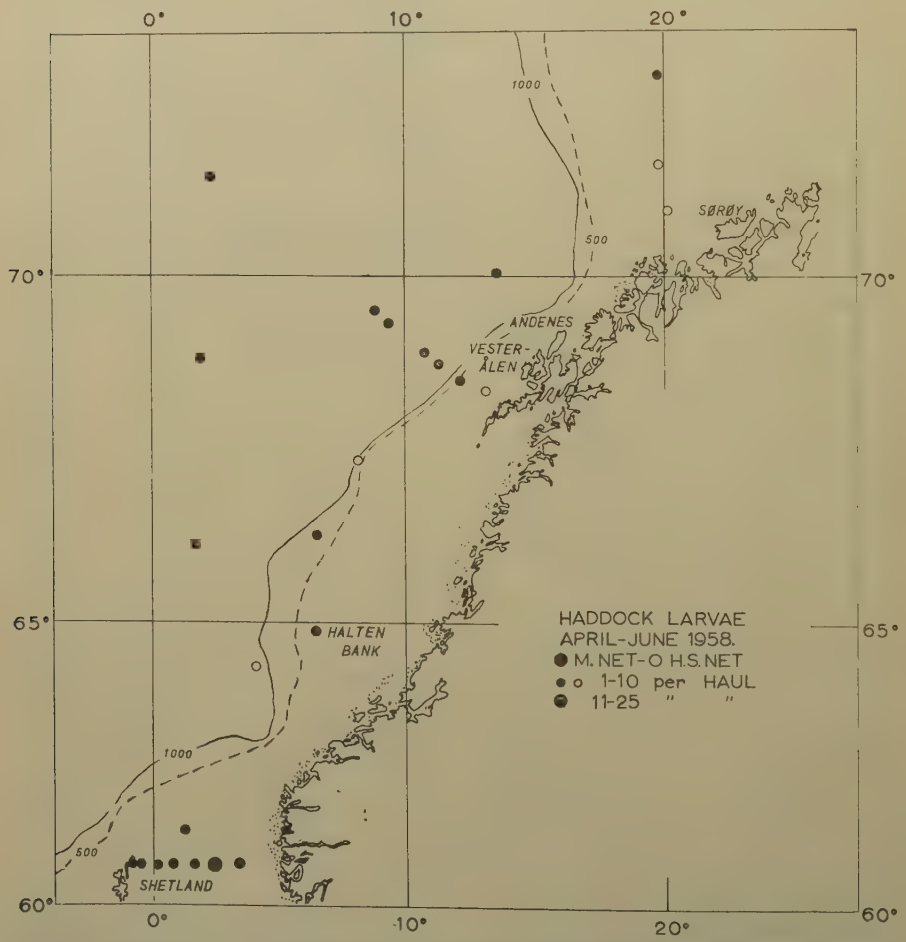

Fig. 10. Distribution of haddock larvae in April—June 1958. Negative stations omitted.

Most of the larvae measured 5—11 mm, single specimens as much as 18 mm. During the last half of June small haddock, 26—46 mm in length, were caught in the high speed net off Vesterålen.

In July—August the young haddock are dispersed over a wide area of the Norwegian and Barents Seas, but mainly north of 70° N (See Wiborg 1960c).

Saithe

In some years eggs and larvae of saithe may be rather common in the coast and bank areas of northern Norway (Wiborg 1956), but the main spawning areas are located farther south, the northernmost one on the Halten Bank. — Few saithe larvae were taken in 1957. At the end of April 1958 (Fig. 11) a few eggs and larvae were taken east of the Viking

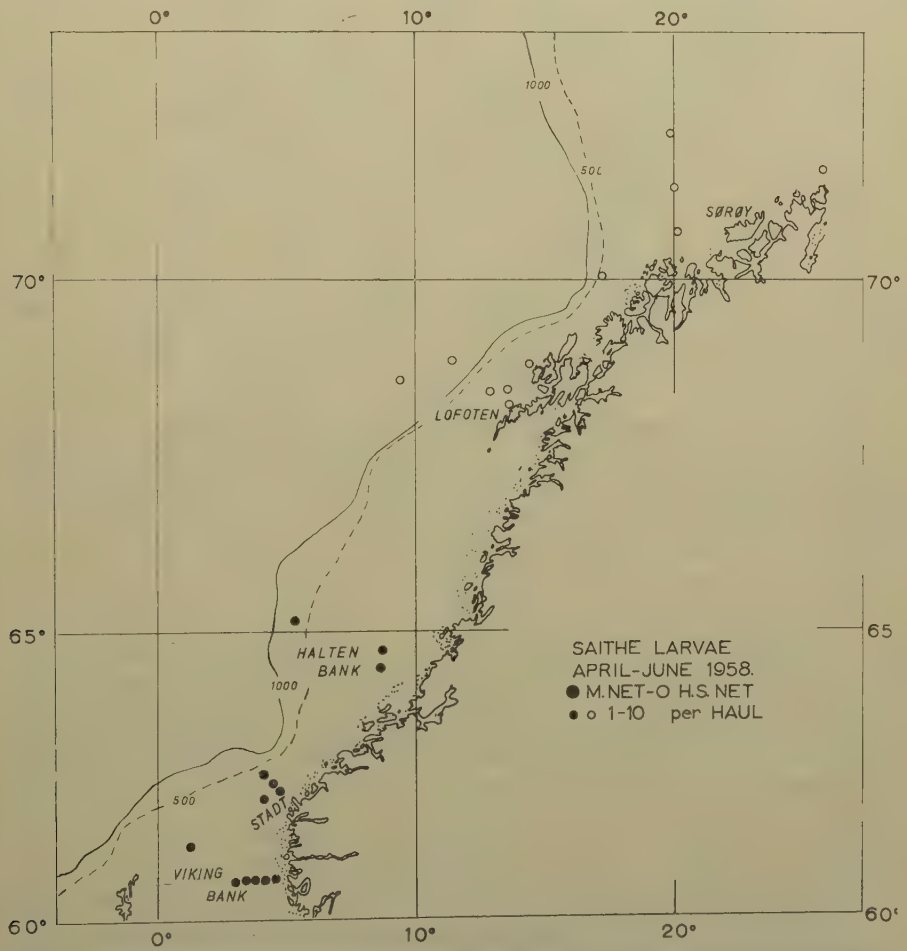

Fig. 11. Distribution of saithe larvae in April—June 1958. Negative stations omitted.

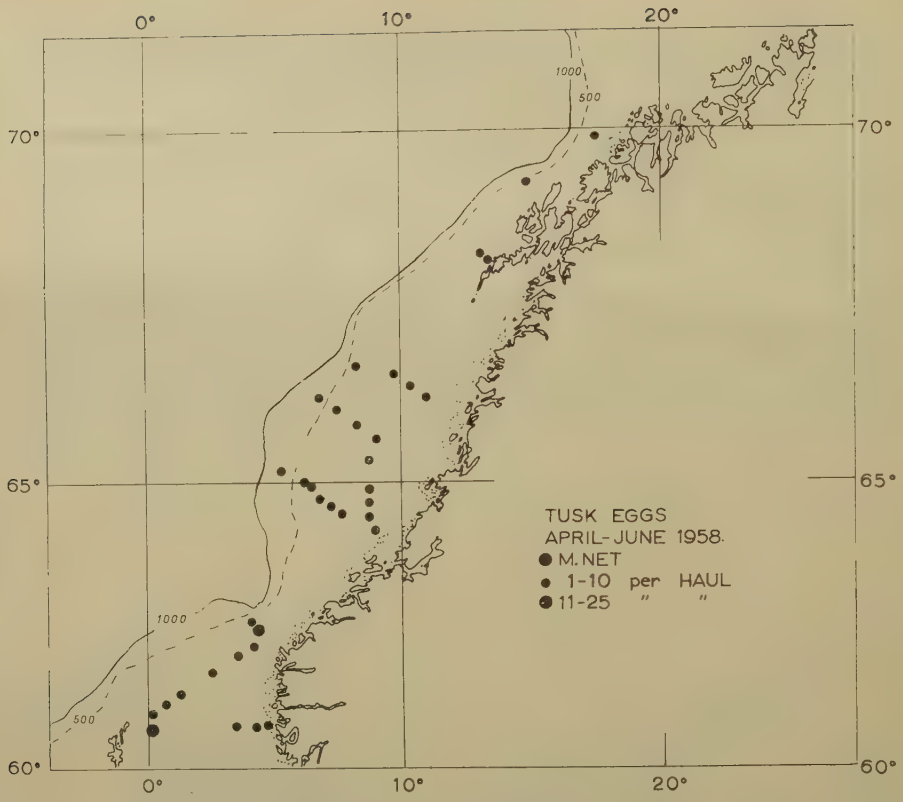

Fig. 12. Distribution of cusk eggs in April—June 1958. Negative stations omitted.

Bank, in the first half of May some also off Stadt and on the Halten Bank. In June single young saithe, 17—45 mm in length, were caught with the high speed net on the coastal banks between Sørøy and Lofoten.

Cusk

The cusk is rather common in Norwegian coast and bank waters, but eggs and larvae are not specially concentrated in any area. In 1958 (Fig. 12) the eggs were mainly found within the 400 m contour with maximum 15 eggs per vertical haul (20 per m^2). In May, single newly hatched larvae were taken on the Halten Bank. According to earlier investigations, the cusk also spawns in the deep of the Norwegian fjords.

Herring

At the beginning of May 1957, 20—50 herring larvae per m^2 were taken between Ona and Storegga, 3—10 larvae/m^2 on the Frøya Bank, 115/m^2 near Sklinna, and 8—41 larvae/m^2 near Træna (Fig. 13). Farther

Fig. 13. Number of herring larvae per m² of sea surface in April—May 1957. Clarke Bumpus plankton sampler. In brackets: Number of herring larvae taken in 20 minutes high speed net hauls in June 1957.

north a few larvae were caught at the entrance of the Vestfjord and in the Andfjord. The lengths of the larvae varied between 9 and 20 mm.

At the beginning of June of the same year 3—39 herring fry were taken per haul with the high speed net between Andenes and Lofoten, especially off the Hadselfjord and Eidsfjord. In the Vestfjord the fry were more abundant, maximum 62, on an average 18 larvae per haul. The majority was taken at the entrance of the fjord, but the herring was also abundant on the Lofoten banks and in the inner part of the fjord.

Herring fry were also taken near the coast farther south, as shown in Fig. 13. The length frequencies (Fig. 14) were fairly uniform in the

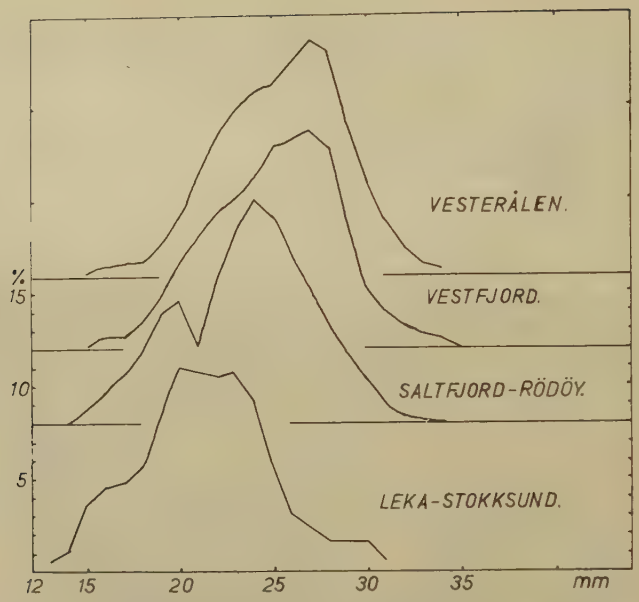

Fig. 14. Length frequencies (in %) of herring fry taken in high speed net in June 1957. (The localities are shown in Fig. 13).

Vesterålen and Lofoten areas, with averages of 25—26 mm. Farther south, inside the Halten and Sklinna banks, the fry were successively smaller, average length 21 mm. The herring fry evidently originate from a spawning area in the south, most probably at Møre, being carried northwards with the coastal current.

In July—August herring fry, 30—40 mm in length, were found in stomachs of cod and haddock in the offshore and coastal areas of northern Norway (Wiborg 1960c).

At the end of April 1958 herring larvae were numerous on two stations northeast of Shetland (Fig. 15). The length distribution was as follows:

9	10	11	12	13	14	15	16	17	18 mm	Mean length
1	1	8	6	15	14	15	6	1	2	13.7 mm.

At the beginning of May larvae were also taken off Stadt and near the Halten Bank, maximum 28 individuals per haul. The average length of the larvae decreased from 19 to 12 mm in a section from the bank towards the coast.

On the banks northwest of Vesterålen only single herring larvae were caught, and observations were probably taken too late in the season to trace the spawning in this area.

From the end of May to the last half of June fairly considerable numbers of herring fry were caught in the high speed net (Table 4).

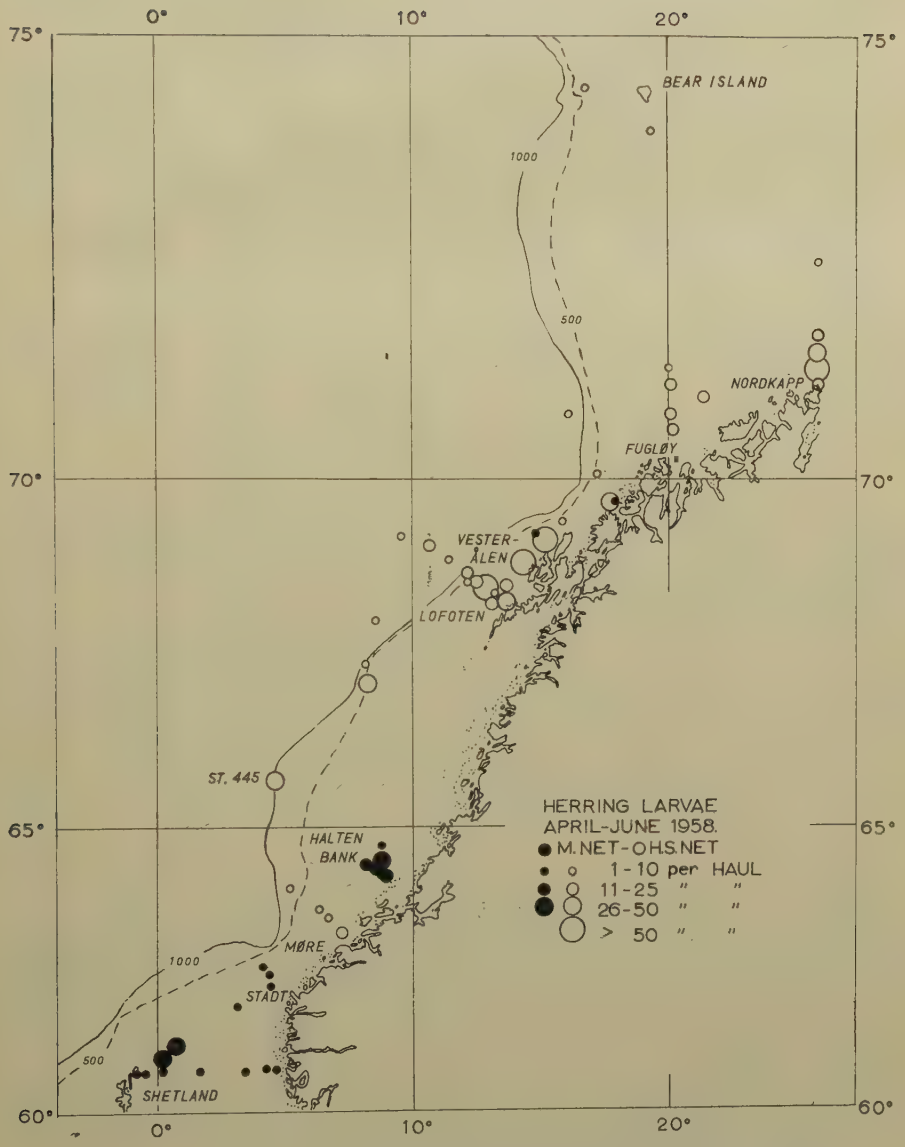

Fig. 15. Distribution of herring larvae in April—June 1958. Negative stations omitted.

Table 4. *Number and Length Distribution of Herring Fry Taken in a High Speed Net (125 -25 m Wire, 25 Minutes, 8 Knots) 31. May—6. June and 17.—24. June 1958 off Western and Northwestern Norway.*

Area	Length in mm								Mean length mm	Mean number per station
	13—17	18—22	23—27	28—32	33—37	38—42	43—47	48—52		
Off Lofoten—Vesterålen 31.V—6.VI ..	2	18	38	15	1	—	—	—	25.2	12
(Bear Isl.)—Fugløy—N. Cape	—	24	112	18	2	—	—	—	25.2	25
N. Cape—Lofoten ..	8	46	95	36	2	—	—	—	24.4	31
Lofoten—Møre	—	15	93	54	10	2	—	—	27.0	17
St. 445	—	—	—	—	1	12	16	4	43.4	

With the exception of one sample (st. 445) the herring fry usually varied in length from 13 to 42 mm, the average lengths from 24.4 to 27.0 mm. The smaller larvae were taken close to the coast, the larger ones farther out at sea.

One haul at the edge (Fig. 15, st. 445) yielded herring fry 37—49 mm of length, mean length 43.4 mm. These herring may have been hatched earlier than the bulk of the fry taken, either off Møre, or perhaps in the Faroe area. On 24. June, herring fry were also caught off Møre, but they were much smaller, with an average length of 25.6 mm.

Redfish

At the beginning of May 1957 some redfish larvae were taken with Clarke Bumpus plankton samplers in the inner part of the Vestfjord, and along the edge northwest of the Lofoten islands, maximum 18 individuals per m^2. Single larvae were caught on the coastal banks northwards to Northcape.

At the beginning of June the redfish larvae were more numerous, with maximum figures 120/m^2.

In the inner Vestfjord the larvae were scarce.

Figures are available of the occurrence of redfish larvae in the Lofoten and Vesterålen areas since 1948, and mean figures have been worked out for different areas for each year (Table 5).

In the Vestfjord the average number of redfish larvae varied between 6 and 23 per m^2 in the period mentioned, with minima in 1950—51 and 1953, maxima in 1948—49 and 1957. Off Vesterålen minima

Table 5. *Mean Number of Redfish Larvae below 1 m² of Sea Surface at the End of May 1948—57.*

Year	Vest-fjord	Vester-ålen	Andenes edge
1948	20	39	37
1949	23	18	—
1950	9	19	18
1951	6	0	3
1952	10	11	—
1953	8	19	29
1954	13	19	21
1955	11	15	6
1956	14	14	—
1957	20	24	24

occurred in 1951—52, maxima in 1948 and 1957, off Andenes minima in 1951 and 1955, maxima in 1948 and 1953. The variations in number may partly be ascribed to variations in the time of spawning. The cruises were usually worked during the latter half of May, from Andenes, across the Vesterålen banks, ending in the Vestfjord.

The larvae usually measured 6—10 mm, and probably belong to local stocks of redfish, perhaps with the exception of those taken off Andenes, which, according to Maslov (1944) may derive from a stock of redfish living in the Barents Sea, the females migrating to the Andenes area to spawn.

On 30. July 1957 a number of cod and haddock of the O-group were caught with a purse seine 120 n. miles northwest of Andenes. (Wiborg 1960c). The fish had mainly eaten postlarval herring and redfish, and 65 small redfish which were in a relatively good condition, measured as follows:

7	8	9	10	11	12	13	14	15	16	17	18	19 mm	Mean length
1	2	4	10	11	17	8	4	3	2	1	1	1	11.9 mm

In 1958 redfish fry were taken chiefly in the vertical hauls between the edge of the continental shelf and the central part of the Norwegian Sea (Fig. 16). The western boundary of the distribution coincides very well with the 4° isotherm at the 20 m level and also with the limits given by Baranenkova et al. (1957). Off Andenes the redfish larvae numbered up to 137 per haul, and the larvae were also numerous farther north,

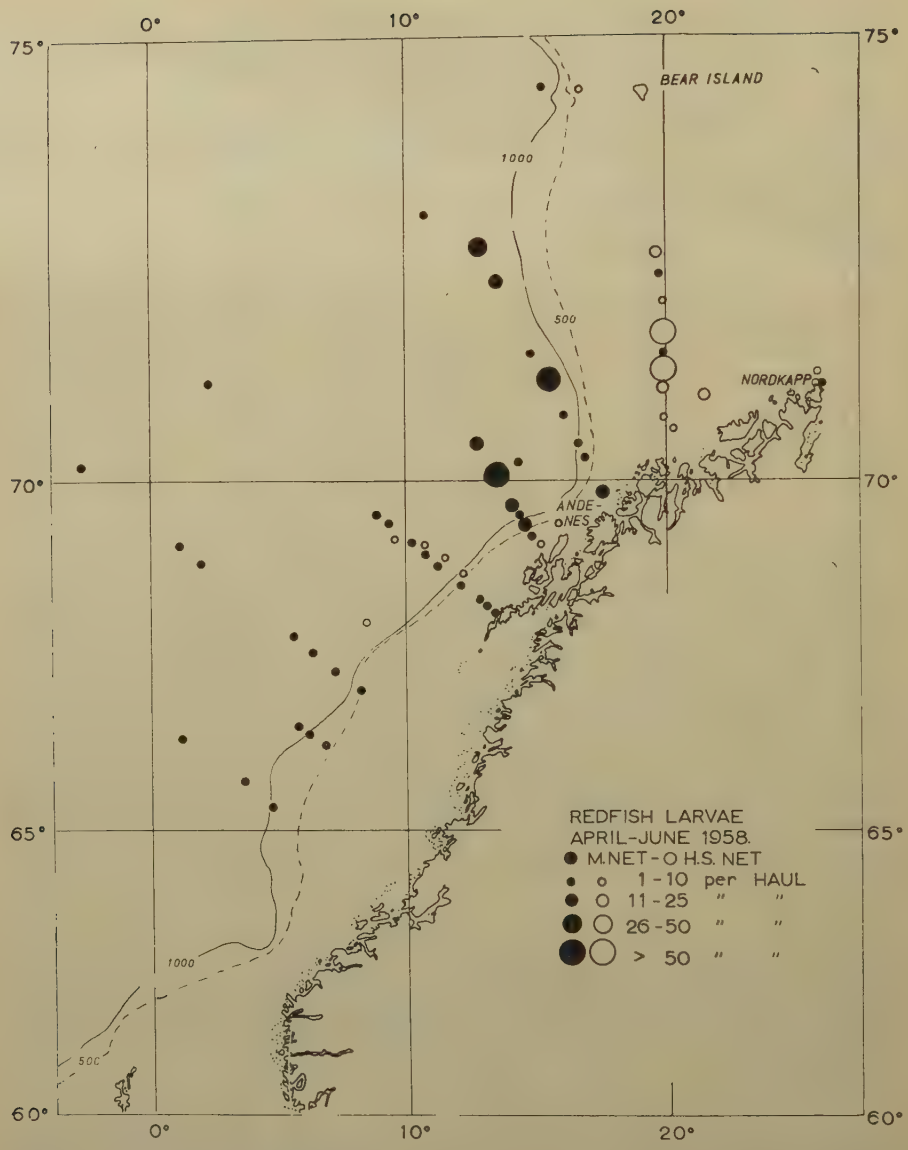

Fig. 16. Distribution of redfish larvae in May—June 1958. Negative stations omitted.

outside the 1 000 m contour. In all areas the lengths varied between 7 and 13 mm. A total of 282 larvae, taken in two sections northwestwards from Andenes and Malangen respectively measured as follows:

7	8	9	10	11	12	13 mm	Mean length
9	49	98	87	31	7	1	9.4 mm

In the middle of June 1958 a number of redfish fry was taken in the high speed net between Bear Island and North Cape, with the following distribution:

7	8	9	10	11	12	13	14	15 mm	Mean length
1	1	8	25	51	55	33	12	5	11.7 mm

A few redfish larvae taken simultaneously in vertical hauls had a mean length of 10.2 mm. — On 13. June three larvae caught in a high speed net west of Bear Island measured 12, 24 and 27 mm respectively. For a study of the growth of redfish larvae it may also be of interest to compare the figures given with the following length frequency of larvae taken in the high speed net at a depth of appr. 30 m on 4. August 1955 at the entrance of the Syltefjord on the Varanger Peninsula:

12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27 mm	Mean length
1	0	0	1	3	3	3	5	5	2	2	2	1	3	0	1	19.8 mm

TÅNING (1949) caught large numbers of redfish fry in the North Atlantic. In June-July these larvae measured 7—22 mm, average size 12—14 mm. These figures are in good accordance with those given above.

Capelin

During the years 1954—56 larvae of capelin did not occur west of North Cape. At the end of May 1957, 30—40 capelin larvae per m^2 were caught on the banks west and south of Sørøy. In this area spawning shoals of capelin were observed at the beginning of March. Later on the fishery for capelin was limited to the areas east of North Cape.

On June 18. 1958, 160 small larvae (8—9 mm) were taken in a vertical haul off North Cape.

SUMMARY

The size frequencies of cod and haddock eggs, sampled in coastal and offshore waters of northwestern Norway have been studied. Within the same species, variations in the mean size of the eggs have been observed, as well as differences in the mean size between eggs of cod and haddock. During the years 1951—58 the cod eggs at Skrova in the Lofoten area decreased in mean size during the spawning season. Following HEINCKE & EHRENBAUM (1900), the size variations are thought to be partly related to decreasing egg size in the individual fish during the spawning season, partly to decreasing size of the fish from the beginning to the end of the same season.

In 1957 cod eggs and larvae were relatively scarce at Skrova, but in 1958, — abundant.

Length measurements of cod fry taken in a high speed net at varying depths near Skrova in June 1957 indicate that the smaller fry as a rule keep to greater depths.

In April 1957 fish eggs, probably of haddock, were moderately abundant along the edge off Lofoten and Vesterålen.

In April—May 1958 haddock eggs and larvae were mainly found east of Shetland and off Vesterålen, some also west of the Halten Bank.

Cusk eggs were distributed within the 400 m contour from Shetland to the north of Andenes.

Saithe larvae were mainly taken on Tampen, off Stadt, and on the Halten Bank.

In May 1957 herring larvae were taken in moderate numbers on the coast banks from Ona to Træna, a few also farther north. In June larger herring fry were relatively numerous in the same areas, in the Vestfjord, and on the coast banks farther north. The mean length of this herring decreased southwards from Vesterålen to Møre.

In April—May 1958 small herring larvae were abundant northeast of Shetland, off Stadt, and on the Halten Bank. From the end of May to the second half of June larger herring fry (13—42 mm) were taken in numbers from off Vesterålen and southwards.

The abundance of redfish larvae in coastal and offshore waters of northern Norway has been studied, and average figures are given for a series of years. In May—June 1958 redfish larvae were abundant in the same waters, especially outside the edge from Andenes and northwards. The western limit of the distribution of the redfish larvae in the Norwegian Sea coincides with that given by BARANENKOVA et al. (1957).

Length measurements indicate an increase in the mean size of the redfish larvae from about 9 mm at the beginning of June to near 20 mm in coastal areas in August.

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